DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
SPECIFICATION

VORTAC MONITOR AND DIAL MONOPHONE PANEL

1. SCOPE

1.1 Scope.- The equipment specified herein is a VORTAC Monitor and Monophone panel to be used for the control and monitoring of remote VORTAC facilities and shall contain the latest state-of-the-art provisions for dial control, monitoring and monophone functions.

2. APPLICABLE DOCUMENTS

2.1 FAA documents.- The following FAA documents of the issues specified in the invitation for bids or request for proposals, form a part of this specification:

FAA-D-2494/1 & 2	Instruction Books, Equipment and Systems
FAA-G-2100/1	Electronic Equipment Part I, General Requirement for all Equipments.
FAA-G-2100/3	Part 3, Requirements for Equipments Employing Semiconductor Devices
FAA-G-2100/4	Part 4, Requirements for Equipments Employing Printed Wiring Techniques
FAA-G-2100/5	Part 5, Requirements for Equipments Employing Micro-Electronic Devices

FAA-G-2300 Panel and Vertical Chassis Rack

2.1.2 FAA standard

FAA-STD-013 Quality Control Program Requirements

FAA-STD-012 Paint System for Equipment

2.2 Military and federal publications.- The following military and federal publications, of the issues in effect on the date of the invitation for bids or requests for proposals, form a part of this specification and are applicable to the extent specified herein.

2.2.1 Federal standard

Federal Standard 595 Color No. 30372

(Copies of this specification and of the applicable FAA specification may be obtained from Federal Aviation Administration, Washington, D.C. 20591, Attention: Contracting Officer. Requests should fully identify material desired, i.e., specification numbers, dates, amendment numbers. Also, requests should state the contract involved or other use to be made of the requested material.)

3. REQUIREMENTS

3.1 Equipment to be furnished by the contractor.- Each piece of equipment furnished by the contractor shall be complete in accordance with all specification requirements. Type "A" instruction books shall be furnished in accordance with FAA-D-2494/1 and /2 and as specified in the contract. The equipment shall consist of a main panel that shall contain a plug-in dialing assembly unit and five plug-in modules, which provide normal and failure indications and selective switching relative to the individual remote sites. The auxiliary panel shall contain slots for up to 8 plug-in modules for monitoring additional sites and also be controlled by the main panel. The slots shall be covered with removable blank panels supplied by the contractor. The main panel shall be designed to control and monitor a maximum of two auxiliary panels, each containing 8 plug-in modules.

3.2.3 Module.- A module is defined as a complete plug-in VORTAC Monitor Removal of any module shall not interrupt the remaining in use modules or derogate performance.

3.3 Construction.- Construction of the chassis shall be based on a standard 19 inch relay rack mounting utilizing sice "C" panel not be exceed 9 inches in depth in accordance with FAA-G-2300. The chassis shall permit suitable cooling without special cooling devices. The plug-in modules shall take the place of a door and the contractor shall supply removable blank panels for unused plug-in modules slots. All modules shall be electrically and mechanically interchangeable.

3.3.1 Chassis guides.- Chassis guide strips and/or rails shall be provided for positive alignment of the plug-in modules. The vertical and lateral movement of a plug-in module shall be restricted to less than 1/32 inch when the unit is inserted more than 3/4 of the distance into the assembly. Plug-in modules shall be removable by use of captive thumb screw fasteners.

3.3.2 Module connectors.- Connectors shall be rigidly mounted to the back of the module chassis and aligned with the mating receptacle so that the connection would occur when the module comes to the end of the cabinet guides in the main or auxiliary panel. These connectors shall be furnished by the contractor.

3.3.3 Extender boards.- Extender boards shall be designed to extend the complete plug-in module from the chassis assembly for testing and trouble-shooting.

3.3.4 Weight.- The total installed weight of the main panel or auxiliary panel finished assembly shall not be more than 50 pounds.

3.3.5 Module fasteners.- Plug-in modules shall be retained by captive thumb screw fasteners. The fasteners shall be constructed to support the weight of the module when held in ones hand after removal from the chassis.

3.3.6 Front panel.- Marking on all units shall be in accordance with specification FAA-G-2100/1, paragraph 3.12.6.1 and 3.12.6.2. Black marking by a "Reserve-etched" process or by a photo-chemical process similar or equal to the wrinlay process may be used.

3.3.7 Designation strips.- Dimension of the designation strips shall be 1½ inches long and ¼ inch wide. A clear plastic window and white bristol board strip shall be installed in each designated strip. The finish of the strips shall be printed Color No. 30372 per federal standard 595.

3.3.8 Nameplate.- The nameplate furnished in accordance with 1.3.13 of FAA-G-2100/1 shall be mounted on the front of the main panel. The following titles shall be used:

"VORTAC Monitor and Dial Monophone Panel"

On the back of the auxiliary panel the following title shall be used:

"VORTAC Monitor Auxiliary Panel"

3.3.9 Wiring.- Wiring shall be in accordance with FAA-G-2100/1, paragraph 1.3.10 and subparagraphs. Shielded pairs shall be used for all audio circuits.

3.3.10.- Terminal boards.- The component terminal boards shall be located in such a manner as to facilitate ease of maintenance. paragraph 1.3.16.11 of FAA-G-2100/1 shall apply.

3.3.11 Semiconductor terminal identification.- All semiconductor mounted on circuit boards shall have a Character "C", representing the collector in a location approximating the collector terminal. In the case of field effect semiconductors the Character "D" representing the drain shall be used. No tubes shall be used.

3.3.12 Main panel.- The main panel shall contain 5 plug-in modules and one plug-in dial assembly unit.

3.3.13 Dial assembly unit.- This unit shall contain one (1) dial assembly that pulses a 540 Hz sender, one (1) speaker for aural monitoring and alarm monitoring, one (1) volume control pot with knob, four (4) captive thumb screw fasteners, one (1) intercom switch pushbutton nonlocking, one (1) monophone jack, 3 conductor open circuit, one (1) 120 V AC and one (1) 24 V DC lighted fuseholder. It shall be a plug-in unit.

3.3.14 Plug-in module.- Each plug-in module shall have two (2) red alarm indicator alternate action switch assembly, two (2) green normal indicator, one (1) aural monitor one position locking type lever switch, one (1) non-indicating fuseholder, one (1) designating strip, one (1) type number plate, two (2) captive thumb screw fasteners, two (2) white neon indicators, and one monophone dial level switch with the following switch arrangement: Position 1 non-locking, left: 1 Form A, 1 Form C, 1 Form B; right: 1 Form A, 1 Form C; Position 2 - Locking, left: 1 Form C, right: 1 Form C and 1 Form B.

3.3.15 AC power cord.- A detachable power cord shall be provided. The length of the power cord shall be six (6) feet.

3.3.16 Defective wiring indication.- This circuitry shall be a means of differentiating between a navaid malfunction and a failure in the wiring which carries the "normal" and "alarm" signal to each plug-in module by causing the green normal indicator to flash in the event of an open circuit. A flasher 24 V DC, 50 to 60 flashes per minute, shall be used.

3.3.17 Reliability requirements.- The contractor shall prepare a reliability prediction report. The report shall contain failure rate date on each part and on each circuit board used in the design. The predicted meantime between failure (MTBF) shall be at least 25,000 hours for the monitoring circuit based on the following conditions:

1. Operation under service conditions of maximum voltage and temperature.

2. Switches operated once per hour

3. Service life of 15 years, operating 24 hours per day and seven days per week.

3.3.18 Maintainability.- The equipment design shall exhibit maximum equipment utilization, consistent with reliability, shall be realized through maintainability practices. Corrective and preventive maintenance shall be considered on the following basis:

1. Corrective maintenance.- In the event of a failure, it shall be possible to restore the equipment to an operational condition within five minutes. This fault correction time is based on removing and replacing with a like module or circuit card.

2. Preventive maintenance.- Preventive maintenance shall be unnecessary or greatly reduced.

The contractor shall supply any special tools required to maintain the equipment.

3.3.19 Design plan.- The contractor shall submit a preliminary design report including an electronics device complement to the contracting officer for review and approval. The plan shall include drawings showing the configuration of all chassis panels and circuit boards with parts layout, schematic and block diagrams.

3.4 Operating characteristic.- Each plug-in module is connected to equipment at a remote site. Indicators on the plug-in module shall reveal remote equipment status on an on/off basis. Switches on plug-in module and the dial on the main panel shall permit the control of communication with the site.

3.4.1 Normal conditions.- A green indicator on each plug-in module when lit shall show normal operation of equipment at the remote site. This is accomplished by 24 VDC supplied by the main panel through closed contact at the remote site. Aural tone monitoring for any site may be selected at its plug-in module. The identification code (voice or tones) for that site will be reproduced at the main panel speaker when dialed on to the line. The normal incoming signal on the control lines shall be audio frequencies between 300 and 3000 Hz at levels from -10 dBm to 0 dBm. The outgoing control voltage shall be 60 Hz (50 to 120 volt) in dial pulse, or audio pulses at levels of -10 dBm to 0 dBm and frequencies of 300 to 3000 Hz. The two (2) white neon indicators with translucent lens indicate which transponder at the TACAN is on, Number 1 or 2. The voltage to these lights will be from 120 VAC to 150 VAC at 2800 Hz to 3000 Hz, and supplied by the TACAN equipment.

3.4.2 Alarm conditions.- When the "normal" signal from the remote site is not received, a contact in the remote site opens and the 24 VDC being supplied by the VORTAC monitor main panel through this contact is removed, a relay in the associated plug-in module is de-energized and upon releasing, applies power to the red indicator in the module and to a relay in the main panel. The relay in the main panel when energized, switches the speaker from the aural monitoring circuit to an alarm frequency provided by the main panel power supply. The aural alarm shall be silenced by pressing the red indicator switch, but the red indicator will remain illuminated. When the malfunctioning VORTAC is restored to operation, the associated relay will be energized, closing the contact which again activates the "normal" circuit, illumination of the green indicator is resumed, the relay in the module is energized and operates, and the relay in the main panel is released. The red indicator is extinguished by pressing the red indicator switch and the module will become normal and ready to alarm on a remote site failure.

3.4.3 Controls.- The dial assembly on the main panel shall permit various remote functions to be performed at a site by AC, DC or tone dialing. A telephone dial is used to pulse a 540 Hz sender. The pulses are carried to the VORTAC site on a telephone line and received by a 540 Hz receiver. The dial signal shall be channeled to the proper site by way of a switch on the associated plug-in module. Calls to the various sites shall be accomplished by holding the dial switch in "Dial" position (on only one module at a time) and dialing the

call code. The key shall be held in "Dial" position a few seconds after dialing is completed to allow the call bell at the remote site to ring, then move the key to monophone position with monophone handset (sound powered) plugged into the monophone jack, the circuit is ready for talking to the person answering the call at the remote site.

4. QUALITY ASSURANCE PROVISIONS

4.1 General.- Section 1-4 of FAA-G-2100/1 set forth classification of tests and general methods of inspection. The contractor shall provide and maintain a quality control program which meets the requirements of FAA-STD-013.

4.2 Design qualification tests. Under normal test conditions the following design qualification tests shall be made:

TEST	PARAGRAPH
Construction	3.3
Chassis guides	3.3.1
Module guides connectors	3.3.2
Module fasteners	3.3.5
Front panel	3.3.6
Designation strips	3.3.7
wiring	3.3.9
Terminal boards	3.3.10
Plug-in dial assembly	3.3.13
Plug-in modules	3.3.14
Operating characteristic	3.4, (3.4.1, 3.4.2 & 3.4.3)

4.3 Production tests.- The following production tests shall be made:

TEST	PARAGRAPH
Construction	3.3
Wiring	3.3.9
Operating characteristic	3.4, (3.4.1, 3.4.2 & 3.4.3)

NOTE: The last two tests may be combined by application of normal operating voltage and observation of operation of lamps, speaker, switches, etc.

5. PREPARATION FOR DELIVERY

5.1 General.- The equipment shall be prepared for delivery in accordance with MIL-E-17555, Level B, and the contract schedule.

5.2 Individual packing.- When two or more units are packed in a common shipping container, each unit with its accessories shall be packed and marked so that it can be identified and reshipped individually without repacking.

6. NOTES

6.1 General information.- The following paragraphs, subparagraphs circuit descriptions and diagrams are furnished as a matter of information to the contractor. They are not requirements of this specification. The Government does not represent or guarantee that conformance thereto will insure that the resulting product will meet specifications requirements.

6.1.2 Circuit description.- The following description includes power supply and various features of the alarm circuit:

6.1.2.1 Main power supply.- Rectifiers CRI and CR2, Figure 3 conduct alternate half cycles of secondary power, producing a pulsating (120 cps) DC outputs carrying from 0 to 36 volts nominal. The average DC voltage at .637 of peak is 23 volts. Power load will vary with the number of modules in operation. Under normal operating conditions each module consumes 165 milliamperes of current. The main panel circuitry normally consumes 5 milliamperes. A full complement of 21 modules in operation would consume approximately 3.4 amperes. A 4 ampere fuse in series with the equipment load protects the rectifiers from excessive current.

6.1.2.2 Fail-safe alarm circuit.- When operating normally, the VORTAC sustains an associated relay in the monitor amplifier at the equipment room of the Flight Service Station. By way of dry contacts of this relay, 23 volts from the main panel is provided to the module which monitors that particular VORTAC. The voltage energizes the module relay K1 and illuminates the green indicator, which thus indicates the normal operation of the VORTAC.

When the VORTAC fails, an associated monitor output relay drops out and removes the power from the green indicator and relay K1 in the module. Upon the release of relay K1, its contacts apply voltage to the red indicator in the module, causing it to illuminate, and to relay K2 in the main panel, causing it to energize. Relay K2, when energized closes contacts which provide 120 cps pulses on the speaker, and drive it to produce the aural alarm. The aural alarm may be silenced by depressing the red indicator. This actuates the alarm-silence switch. When the switch is in the "silence" position, ground is removed from relay K2 in the main panel, the relay drops out, removing the alarm signal circuit and restoring the aural monitoring circuit to the speaker.

When the alarm-silence switch is actuated, ground is supplied to the red indicator, by passing relay K1. Ground is also applied to the coil of relay K1 so it will be energized when the "normal" circuit is resumed. When the malfunctioning VORTAC is restored to operation, the associated relay will be energized, closing the contacts which again activate the "normal" circuit. The green indicator will be illuminated, and relay K1 will be energized and will remain latched up as long as voltage is applied from the remote monitor relay. The illuminated red indicator may now be extinguished again by depressing the red indicator switch, which action removes the bypass ground from the red indicator and sets up the aural alarm circuit for the next alarm condition.

6.1.2.3 Defective wiring detector.- Three wires from the plug-in module connect to three contacts of a remote relay. This relay is energized when the associated VORTAC is functioning normally. The transfer contact of the relay is provided with 23 volts from the main panel power supply, which is transferred to the contact and wire leading to the "normal" circuit of the appropriate module. There it energizes the green indicator, relay K1, and is fed to the base of transistor Q1 (Figure 4).

If a VORTAC malfunction occurs, the associated remote relay drops out, transferring the 23 volts to the "alarm" circuit of the module, and to the base of transistor A2 (Figure 4). Transistors Q1 and Q2 (Figure 4) are connected in series, and comprise a transistor switch which controls a constant 23 volts from the main panel power supply. This voltage, connected to the emitter of Q2 (Figure 4) would conduct through the series transistors to the thermal flasher by way of the collector of Q2 (Figure 4), except that this path is blocked by the bias voltage of either the "normal" or "alarm" circuits which are connected respectively to the bases of Q1 and Q2 (Figure 4). One of these circuits will always be active when wiring is complete.

If the "normal" circuit should be broken, the module will indicate an alarm condition; but, since a bias no longer exists at the base of Q2 (Figure 4), as would happen in the case of a VORTAC failure, the constant 23 volts, no longer blocked, will pass to the flasher which causes the green indicator to flash. If a VORTAC failure should happen to occur at this time, the green would be extinguished. A break in the "Alarm" circuit would not be indicated at the module until the VORTAC fails and its associated remote relay drops out. The remote relay in the case transfers voltage from the "normal" to the "alarm" circuit which is, of course, imcomplete. Again, lacking a bias voltage, the transistor switch passes the constant 23 volts to the green light flasher.

If the third wire which supplies voltage to the transfer contact of the remote relay should be broken, power is lost in both the "normal" and "Alarm" circuit regardless of the attitude of the remote relay. Bias at the transistor switch is again lost, and the constant 23 volts is passed to the green light flasher. In all instances, a break in external circuitry will be indicated at the module by a flashing green indicator. The broken wire may be determined through a check of voltage or continuity at the remote relay or at points between the relay and monitoring equipment.

Figure 1 and 2 are typical front views of how a VORTAC monitor and auxiliary panel should look. Figure 5 is a block diagram showing how the external cabling for the main panel and auxiliary panel could be done. Figure 6 is a wiring diagram showing how the main panel and auxiliary panel should be wired into the tone equipment, TACAN monitor panel and the audio control equipment.

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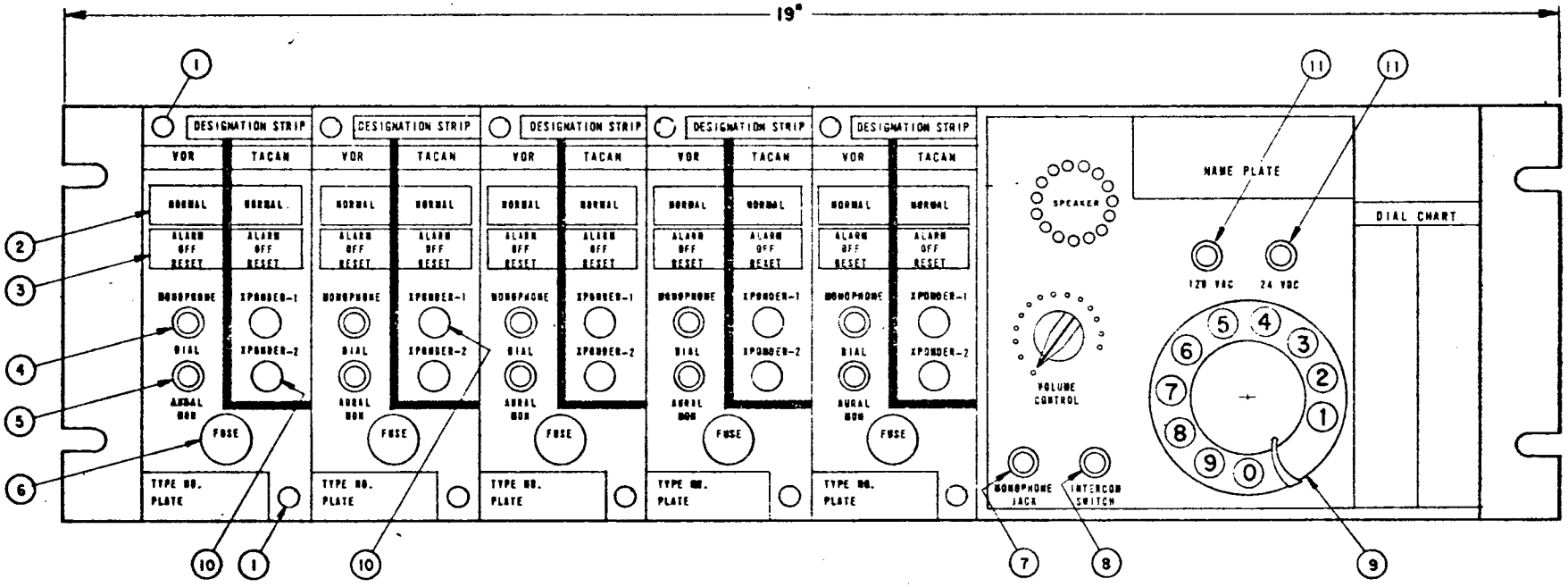

NOTE:

1. CAPTIVE THUMB SCREW
2. INDICATOR ASSEMBLY, GREEN
3. INDICATOR - SWITCH ASSEMBLY, RED, DPDT, ALTERNATE ACTION
4. SWITCH, LEVER, NON-LOCKING POSITION (DIAL POSITION) AND LOCKING POSITION.(MONOPHONIC POSITION)
5. SWITCH, LEVER LOCKING POSITION.(AURAL MONITOR)
6. FUSE HOLDER, NON-INDICATING.
7. PHONE JACK, 3 CONDUCTOR OPEN CIRCUIT.
8. SWITCH, PUSHBUTTON, NON-LOCKING
9. DIAL ASSEMBLY
10. INDICATOR ASSEMBLY, NEON, WHITE TRANSLUCENT LENS.
11. INDICATING FUSE HOLDER, FOR 120 VAC AND 24 VDC.

FIGURE 1

VORTAC MONITOR AND DIAL MONOPHONE PANEL

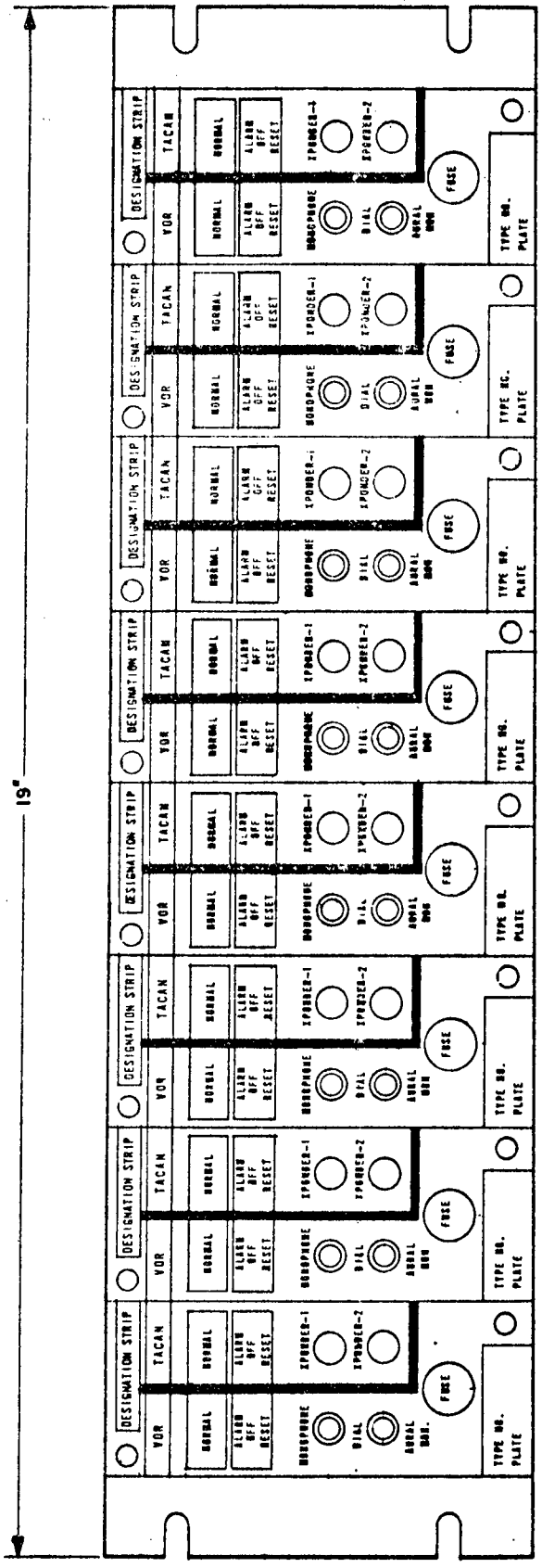

FIGURE 2

VORTAC MONITOR AUXILIARY PANEL

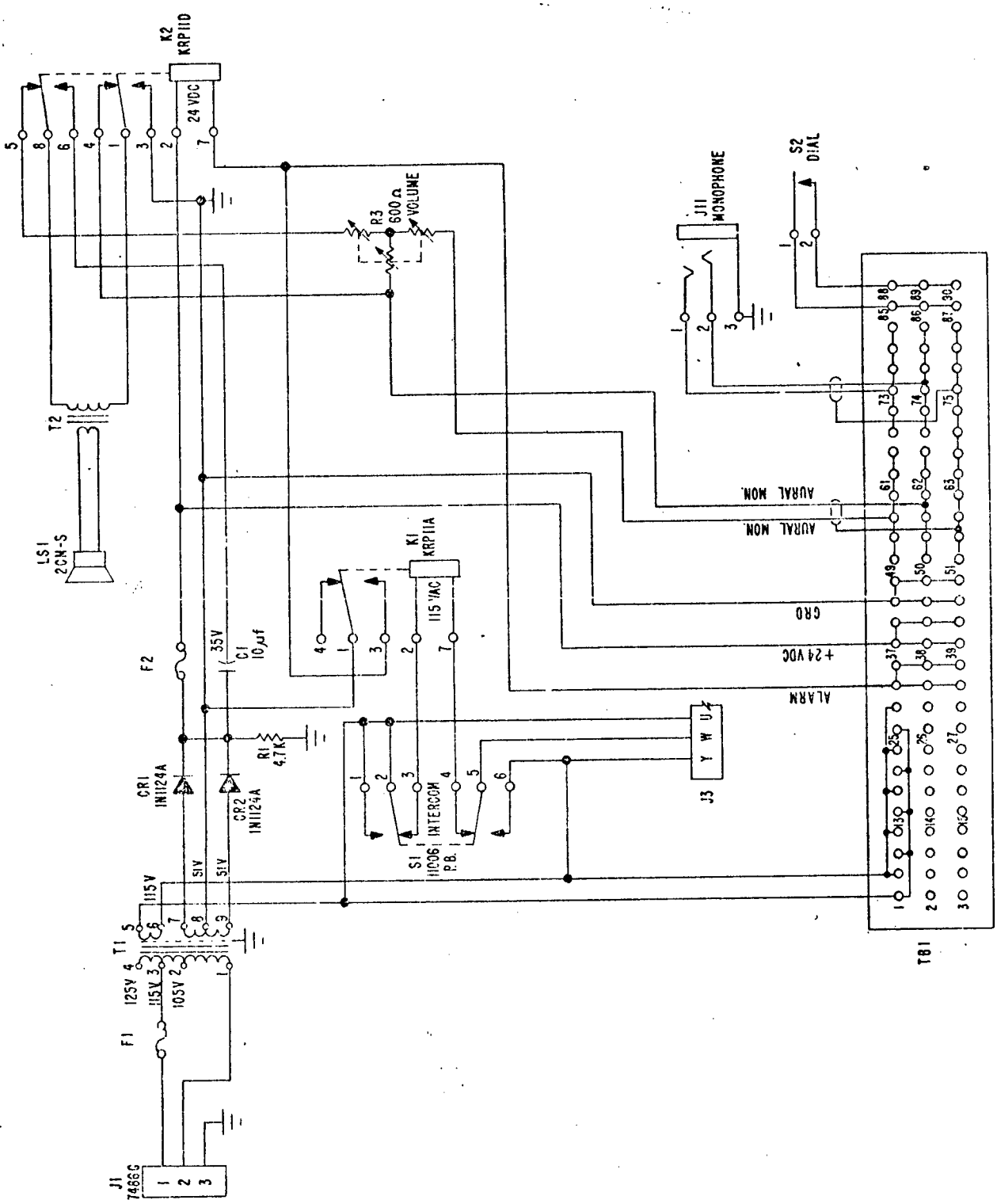

FIGURE 3 MAIN PANEL, SCHEMATIC DIAGRAM

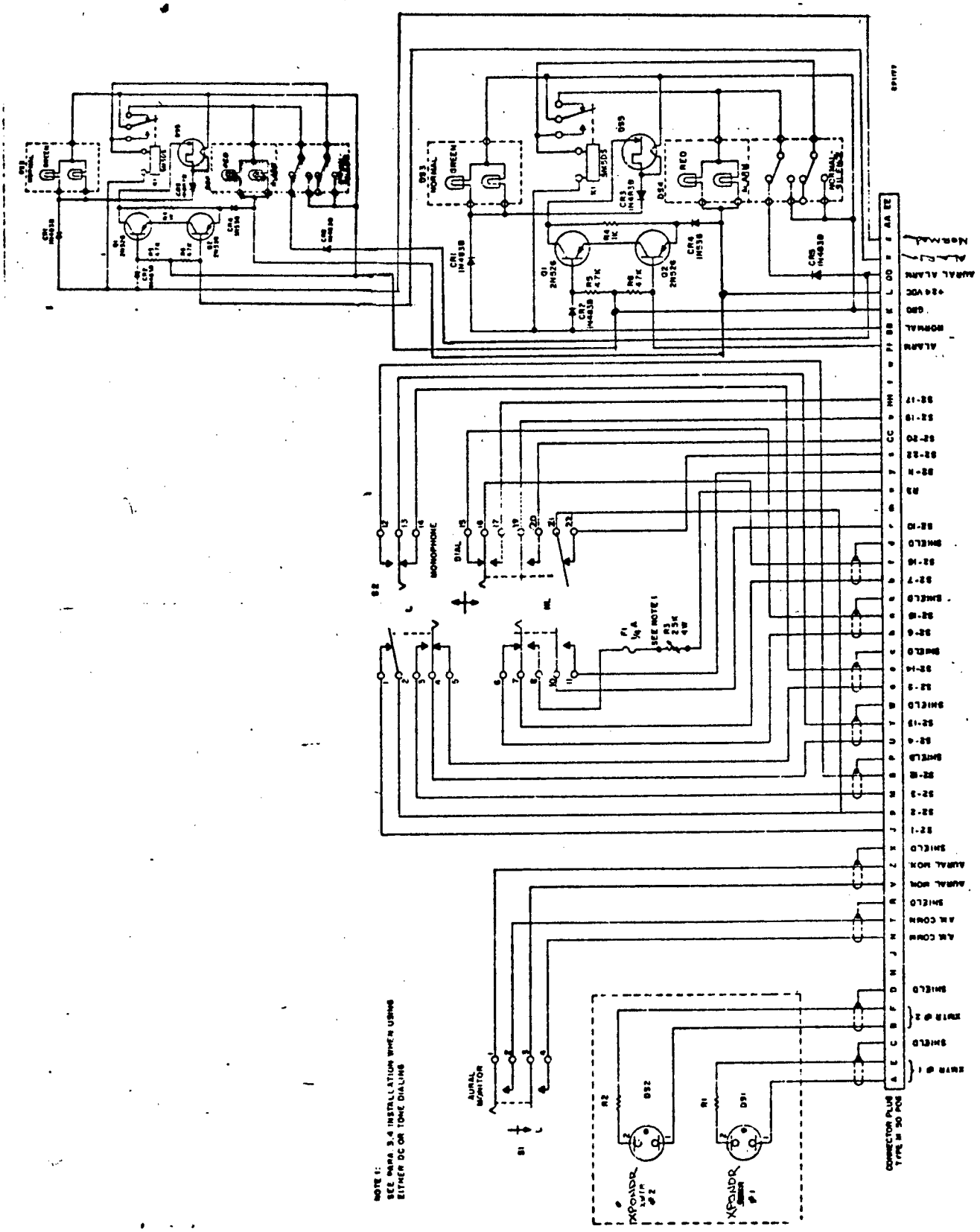

FIGURE 4. PLUG-IN MODULE, SCHEMATIC DIAGRAM

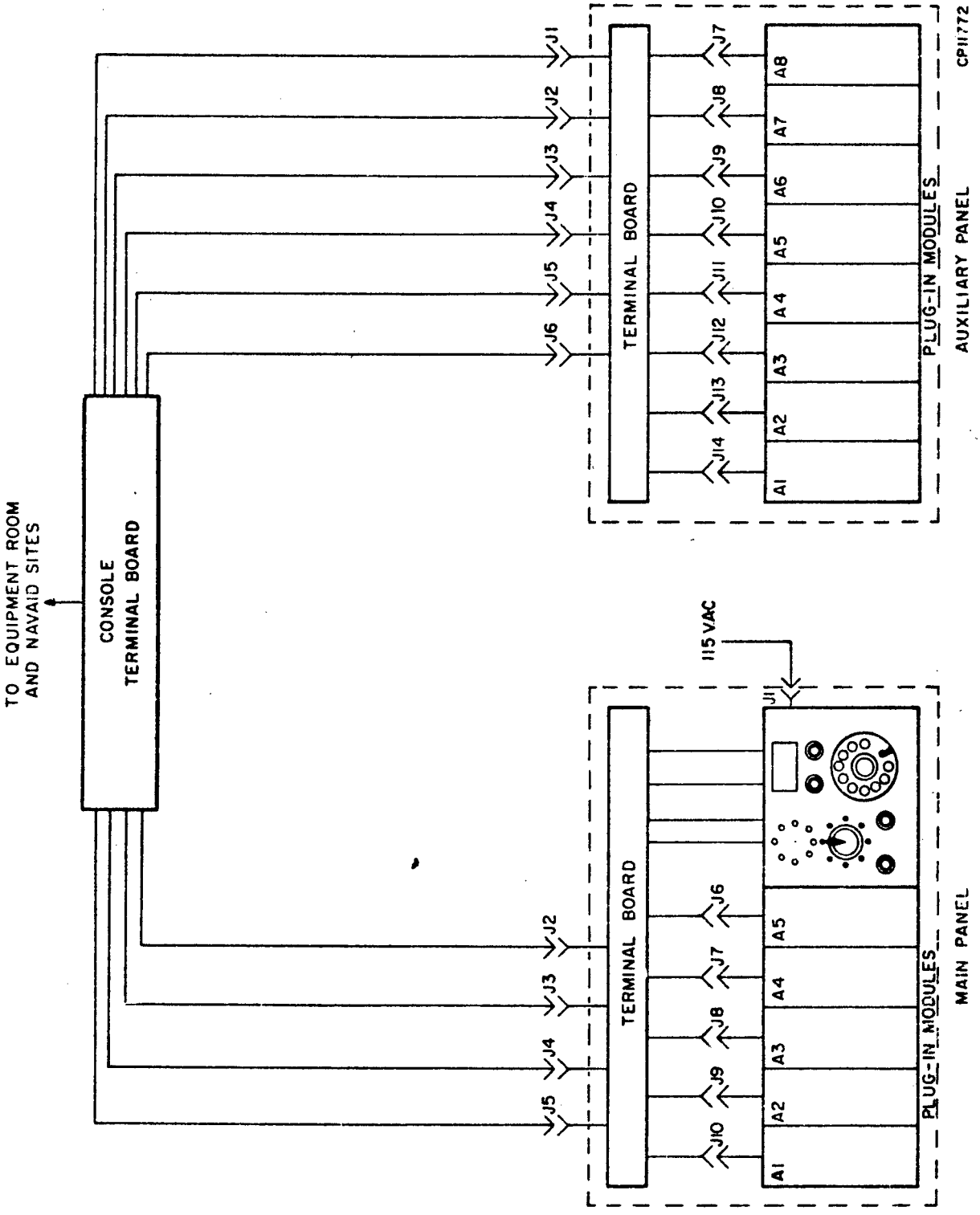

FIGURE 5 MAIN PANEL AND AUXILIARY PANEL, BLOCK DIAGRAM

LEFT INTENTIONALLY BLANK

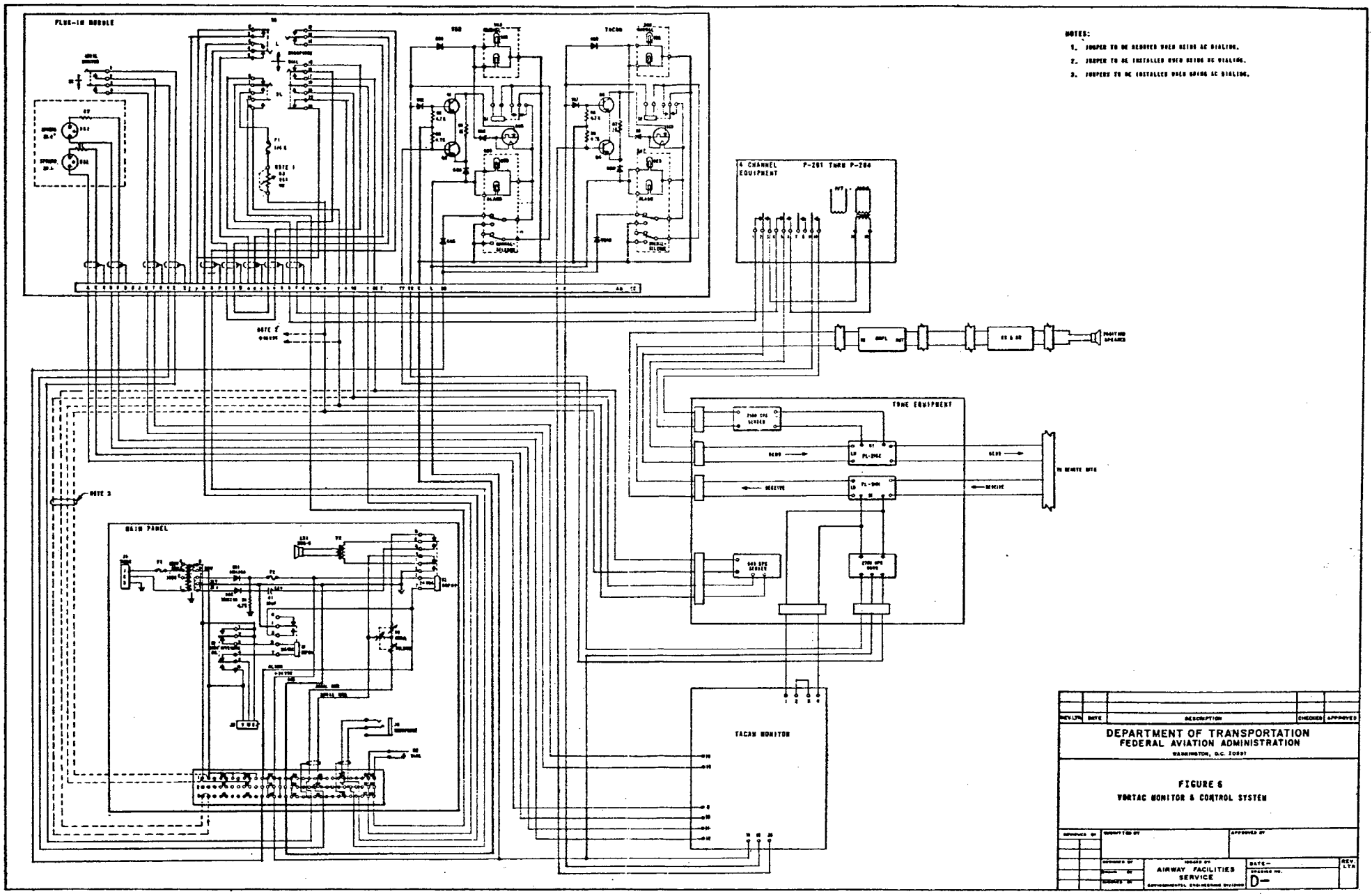

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FIGURE 6
VORTAC MONITOR & CONTROL SYSTEM

AIRWAY FACILITIES SERVICE

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